<u>CLAIMS</u>

1. A method for encoding pixels of digital or
digitized images, i.e. images consisting of a set of
image dots, named pixels in two-dimensional images and
5   voxels in three-dimensional images, each of said pixels
or voxels being represented by a set of values which
correspond to a visual aspect of the pixel on a display
screen or in a printed image, characterized in that the
pixels or voxels (5, 14) of at least one portion of
10 interest of the digital or digitized image or each
pixel or voxel (5, 14) of the set of pixels or voxels
which form the image is uniquely identified with a
vector whose components are given by the data of the
pixels or voxels to be encoded (5, 14) and by the data
15 of at least one or at least some or of all of the
pixels (1, 2, 3, 4, 6, 7, 8, 9; 1, 2, 3, 4, 5, 6, 7, 8,
9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23,
24, 25, 26, 27) around the pixels to be encoded and
arranged within a predetermined subset of pixels or
20 voxels included in the whole set of pixels or voxels
which form the image.

2. An encoding method as claimed in claim 1,
characterized in that the components of the pixel or
voxel (5, 14) identifying vector are determined by
25 selecting, as pixels or voxels surrounding the pixel to
be identified, all the pixels or voxels (1, 2, 3, 4, 6,
7, 8, 9; 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12, 13, 15,
16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27) that
are directly adjacent to said pixel or voxel to be
30 encoded.

3. A method as claimed in claim 1 or 2, characterized in that the components of the identification vector of a pixel or voxel to be encoded (5, 14) also consist of at least one or at least some

5   or at least all of the pixels or voxels surrounding the pixels or voxels (1, 2, 3, 4, 6, 7, 8, 9; 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27) that are directly adjacent to said pixel or voxel to be encoded (5, 14).

10   4. A method as claimed in one or more of the preceding claims, characterized in that the components of the identification vector, corresponding to the pixel or voxel to be encoded (5, 14) and to the surrounding pixels or voxels (1, 2, 3, 4, 6, 7, 8, 9;

15 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27) are arranged in such a manner as to correspond to the distance relation of said pixels or voxels (1, 2, 3, 4, 6, 7, 8, 9; 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18,

20 19, 20, 21, 22, 23, 24, 25, 26, 27) with one another and with the pixel or voxel to be encoded (5, 14), with reference to a predetermined reading sequence of surrounding pixels or voxels (1, 2, 3, 4, 6, 7, 8, 9; 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17,

25 18, 19, 20, 21, 22, 23, 24, 25, 26, 27), selected for forming said identification vector and the pixel of voxel to be encoded (5, 14).

5. A method as claimed in one or more of the preceding claims, characterized in that the components

30 of the identification vector are arranged in such a

manner that the pixel or voxel to be encoded (5, 14)
has a central position which corresponds to the one
taken in the image pixel or voxel set, obviously as
related to the pixels or voxels (1, 2, 3, 4, 6, 7, 8,
5   9; 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16,
17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27),
surrounding the pixel or voxel to be encoded (5, 14)
which have been selected for determining the
identification vector components.

10   6. A method as claimed in one or more of the
preceding claims, characterized in that it includes the
step of encoding a sequence of digital or digitized
images of a single subject and relating to a single
frame of said subject, which sequence includes at least
15   two images acquired with a time interval therebetween,
which identification vector for a pixel or voxel (5) to
be encoded, having the same position in the pixel
matrix which forms said sequence images, is formed by
the value of said pixel or voxel to be encoded (5) and
20   by the surrounding pixels or voxels selected to form
the components of said identification vector for each
image that is part of said image sequence.

         7. A method as claimed in claim 6, characterized
in that the identification vector for a pixel or voxel
25   to be encoded (5) within a sequence of digital or
digitized images includes the values of said pixel or
voxel to be encoded and of the pixels or voxels
selected to form the components of said identification
vector of all the images of said sequence, the values
30   of the pixel or voxel (5) to be encoded and of the

pixels or voxels around it, selected to form the components of the identification vectors, being ordered with respect to the instant whereat the individual images of the sequence were acquired, in such a manner

5   as to form subsets of identification vector components, referred to the same image of the image sequence or to the same acquisition instant.

8. A method as claimed in claim 7, wherein the subsets of identification vector components referred to

10   the different images of an image sequence are successively ordered with reference to the instant whereat the corresponding image of the image sequence to be encoded was acquired.

9. A method of processing digital or digitized

15   images, operating based on image pixel or voxel encoding as claimed in one or more of the preceding claims 1 to 8 and 35 to 39, and characterized in that it includes generation of a teaching database and teaching of the processing system, including the

20   following steps:

- Encoding a predetermined number of digital or digitized images into pixel or voxel identifying vectors;

- uniquely associating each identification vector

25   to the corresponding type of object or to the corresponding quality, as determined by traditional image analysis and actually reproduced by each pixel or voxel encoded by the corresponding identification vector, with reference to a list of predetermined

30   different types or qualities.

- Generating a teaching database for a processing system, which database comprises the binomials formed by said identification vectors and by the associated type or quality of the object reproduced by the corresponding pixel or voxel;

- Actually teaching the processing system, by entering and loading the teaching database therein or by allowing the processing system to access the database;

A repeatable processing step for different images or image sequences with no need to repeat the teacning step, and comprising the following steps:

- Encoding the pixels or voxels of a not otherwise evaluated image by identification vectors associated to each pixel or voxel;

- Entering said image pixel or voxel identifying vectors in the processing system to obtain, at the output of said processing system and as a result of the processing, the type or quality of the object represented by each image pixel or voxel, with reference to the object types or qualities included in the teaching database.

10. An image processing method as claimed in claim 9, characterized in that the processing system consists of an algorithm for comparing the pixel identifying vectors of the teaching database with the pixel identifying vectors of the encoded images to be processed or of the sequence of encoded images to be processed.

11. A method as claimed in claim 9 or 10,

characterized in that the processing system consists of
a discriminating algorithm, of the type known as LDA.

12. A method as claimed in claim 9 or 10,
characterized in that the processing system consists of
5   an algorithm known as a neural network.

13. A method as claimed in one or more of the
preceding claims 9 to 12, characterized in that the
pixels or voxels of the processed image wherefor an
object type or quality has been recognized are
10   displayed differentially from each other and from the
image, e.g. thanks to a certain aspect, like a
predetermined different color or the like for each
object type or quality option.

14. A method as claimed in claim 13, characterized
15   in that the pixels or voxels of the processed image
wherefor an object type or quality has been recognized
are displayed differentially from each other and from
the image, e.g. thanks to a certain aspect, like a
predetermined different color or the like for each
20   object type or quality option, and over the original
image.

15. A method as claimed in claim 14, characterized
in that the original image is displayed in a
monochromatic mode, particular in black and white or a
25   gray scale.

16. A method as claimed in one or more of the
preceding claims 9 to 15, characterized in that the
results of image processing are stored in the teaching
database for the processing system.

30   17. A method as claimed in claim 16, characterized

in that, before being stored in the teaching database, the image processing results are validated by a visual control and/or other analysis means.

5   18. A method as claimed in claim 16 or 17, characterized in that image processing results are stored in the form of identification vectors for the pixels or voxels of the processed image, associated to the object type or quality assigned thereto upon processing.

10   19. A method as claimed in one or more of the preceding claims 9 to 18, characterized in that it is a method for recognizing types of objects reproduced by image pixels or voxels.

       20. A method as claimed in one or more of the
15   preceding claims 1 to 19 and 35 to 39, characterized in that it is a method for processing digital or digitized diagnostic images, aimed at the recognition of at least one type of tissue or anatomic or physiologic object or one quality thereof.

20   21. A method as claimed in claim 20, characterized in that it is a diagnostic image processing method for recognizing and discriminating benign tumor tissues and malignant tumor tissues, as reproduced by the pixels or voxels of the diagnostic images, the teaching database
25   being composed of identification vectors for image pixels or voxels that represent said malignant and benign tumor tissues, uniquely associated to the corresponding tissue type.

       22. A method as claimed in claim 21, characterized
30   in that it is a method for recognizing and

discriminating benign tumor tissues, malignant tumor
tissues and normal tissues, as reproduced by the pixels
or voxels of the diagnostic images, the teaching
database being composed of identification vectors for
5   image pixels or voxels that represent said malignant
and benign tumor and normal tissues, which vectors are
uniquely associated to the corresponding tissue type
reproduced by the pixels or voxels encoded into said
vectors.

10   23. A method as claimed in claim 22, characterized
in that it is a method for recognizing and
discriminating benign tumor tissues, malignant tumor
tissues, normal tissues and muscular tissues as
reproduced by the pixels or voxels of the diagnostic
15   images to be processed, the teaching database being
composed of identification vectors for image pixels or
voxels that represent malignant and benign tumor
tissues, normal and muscular tissues, which vectors are
uniquely associated to the corresponding tissue type
20   reproduced by the pixels or voxels encoded into said
vectors.

        24. A method as claimed in one or more of claims
21 to 23, characterized in that it is a method for
recognizing and discriminating benign tumor tissues
25   and/or malignant tumor tissues and/or normal tissues
and/or muscular tissues and image background, as
reproduced by the pixels or voxels of the diagnostic
images to be processed, the teaching database being
composed of identification vectors for image pixels or
30   voxels that represent malignant and/or benign tumor

tissues, and/or normal and/or muscular tissues and image background, which vectors are uniquely associated to the corresponding tissue type or background reproduced by the pixels or voxels encoded into said

5   vectors.

25. A method as claimed in claims 9 to 20, characterized in that it is a method for measuring contrast agent perfusion, wherein a sequence of ultrasound or Nuclear Magnetic Resonance images of a

10   predetermined anatomic part of a patient are detected after injecting so-called contrast agents in said anatomic part, which method includes the following steps:

- Generating a teaching database for the expert

15   processing system comprising identification vectors for pixels or voxels or image sequences obtained when contrast agents are present, whereto a quality or type o perfusion behavior is associated, among different typical perfusion types or qualities;

20   - Actually teaching the processing system, by entering or handling data of the teaching database;

- Acquiring a sequence of images of an anatomic part after injecting contrast agents therein, and encoding the pixels or voxels of the images of said

25   sequence, acquired as claimed in the preceding claims 1 to 8, into identification vectors for the pixels of said image sequence;

- Processing by the identification vector processing algorithm, which associates, based in the

30   teaching database, a perfusion behavior type or a

perfusion quality to each identification vector, hence to each pixel or voxel of the image sequence;

- Displaying the image sequence, and highlighting the pixels or voxels associated to the different
5   perfusion behavior qualities or types by means for unique visual aspect characterization of said pixels or voxels.

26. An image processing method as claimed in one or more of the preceding claims 9 to 20, which includes
10   an image pixel or voxel encoding method according to the encoding method as claimed in claims 1 to 8, characterized in that it is a method for recognizing and displaying parts of moving organs or physiological structures, particularly of the heart, wherein a
15   sequence of ultrasound or radiographic or Nuclear Magnetic Resonance images of the heart or of any other organ or physiological structure is acquired, which method includes the following steps:

-    generating a teaching database in which each
20   identification vector for pixels or voxels of a plurality of image sequences of the heart or any other organ or physiological structure encoded with the method as claimed in one or more of claims 1 to 8, is assigned the type or quality of what is reproduced by
25   the corresponding pixel or voxel;

-    Actually teaching the processing system, by entering or handling data of the teaching database;

- Encoding, by using the method as claimed in one or more of claims 1 to 8, a sequence of images of the
30   heart or any other organ or physiological structure for

further processing;

    - Processing said encoded sequence of images so that the processing algorithm may assign, based on the teaching database, the type or quality reproduced by

5   each pixel or voxel of the encoded image sequence

    - displaying the result and visually highlighting the pixels of voxels corresponding to specific types or qualities by uniquely changing the aspect of these pixels of voxels according to each of the specific

10   types or qualities.

    27. A method as claimed in one or more of claims 9 to 20, in combination with an image encoding method as claimed in one or more of claims 1 to 8 and for recognizing image defects or aberrations, wherein the

15   following steps are included:

    -    generating a teaching database by encoding image pixels or voxels into identification vectors as claimed in one or more of claims 1 to 8, and wherein each identification vector for the pixels or voxels of

20   said images is assigned the type or quality which defines the presence or absence of the image defect or aberration depending on whether the corresponding pixel or voxel reproduces or has or not said aberration or said defect;

25   -   Actually teaching the processing system, by entering or handling data of the teaching database;

    - Encoding images, by using the method as claimed in one or more of claims 1 to 8 and 35 to 39;

    - Processing said encoded images so that the

30   processing algorithm may assign, based on the teaching

database, the type or quality which defines the
presence or absence of an image defect or aberration
for each pixel or voxel of the encoded images;

Displaying the result and visually highlighting,
5   by aspect change arrangements, the pixel/s or voxel/s
which have been assigned the type which defines the
presence of aberrations or defects and possibly
indicating the quality of the aberration or defect
assigned to a pixel or voxel, as distinct from the one
10   assigned to other pixels or voxels, by further aspect
differentiation of the pixel/s or voxel/s, uniquely
related to the different defect or aberration
qualities.

28. A method as claimed in claim 27, characterized
15   in that it further includes defect removal, according
to the following steps:

- Adding to the teaching database pairs of encoded
images, which have or do not have image defects or
aberrations, by associating the identification vectors
20   with the corresponding types defining the presence or
absence of pixel aberration;

- Encoding the pixels or voxels of an image and
processing the latter to assign the type that defines
the absence of presence of aberrations or defects, and
25   possibly the quality of said aberrations or defects to
each pixel or voxel of the image;

- Correcting the aspect of the pixels of voxels
which have been found to have defects or aberrations by
assigning them the aspect of the defect- or aberration-
30   free pixels or voxels of the image, which is coupled,

in the teaching database, to the corresponding image which has said aberrations or defects.

29. A method as claimed in claim 27 or 28, characterized in that the processed images are
5   previously or subsequently processed for specific recognition of the object types represented by the pixels.

30. A method as claimed in one or more of claims 27 to 29, characterized in that the type of defect or
10   aberration is a defocusing defect and/or an artifact and/or a wrong exposure and/or a defective development.

31. A method as claimed in one or more of the preceding claims 9 to 20, in combination with an image pixel or voxel encoding method as claimed in one or
15   more of claims 1 to 8 and/or 35 to 39, characterized in that it is a method of overlaying digital or digitized images of the same subject, obtained by different imaging techniques, which includes the following steps:

- Encoding each of the images of the same subject,
20   obtained with different imaging techniques, as claimed in one or more of claims 1 to 8 and/or 35 to 39 ;

- Processing each of the images of the same subject, obtained with different imaging techniques, for recognizing types of objects or qualities as
25   claimed in one or more of claims 9 to 26;

- Combining the information provided by the pixels of the different images, which are assigned to the same type of object, into a single image.

32. A method as claimed in one or more of claims
30   27 to 31, characterized in that it is provided in

combination with a method as claimed in one or more of
claims 9 to 26.

33. A method as claimed in one or more of the
preceding claims, characterized in that the digitized
5 image is an image whose pixel size corresponds to a
high resolution, below human eye resolution, the pixel
data which are processed for recognition as claimed in
claims 9 to 32, being used to control all the pixels of
a high resolution pixel unit group which has such a
10 number of pixels that the aspect of all the pixels of
each pixel unit group is identical to that of the high
definition pixel associated thereto and the displayed
or printed image of said pixel unit group may be viewed
or detected at the human eye resolution or worse.

15 34. A method as claimed in claim 33, characterized
in that the number of high definition pixels which form
the pixel unit group is adjustable and allows to define
different enlargement levels.

35 A method according to one or more of claims 1
20 to 8 characterised in that instead of considering an
image formed by single pixels, for coding purposes a
minimu image area of different size may be defined
which is formed by a predefinite certain number of
adiacent pixels, the value of the said minimum image
25 area formed by the said certain number of adiacent
pixels being calculated as a linear or non linear
combination and/or as the value of one or more
statistical functions of the of the brightness and or
color values of the single pixels forming the said
30 minimum image area.

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36. A method according to claim 34, charaterised in that as a value of the minimu image area it is used the mean of the brightness values of the single pixels forming the minimum image area and/or the variance

5   thereof and/or additionally the mean and or the variance value of the colour values of the single pixels.

37. A method according to claims 35 or 36, characterized in that also the time dependency of the

10   values relating to brightness and/or color of the single pixels forming the minimu image area is added, the time dependency of the combinations and/or of the statisitical functions of the brightness and or color values of the single pixels being used.

15   38 A method according to one or more of the preceding claims 35 a 37, characterized in that there are defined minimum neighborhood image area zones of the minimum image area to be coded each of which minimum neighborhood image area zones may be formed by

20   a single selected pixels in the neighborhood of the minimum inage area to be coded or as a certain number of said pixels in the neighborhood of the said minimum image area to be coded.

39. A method according to claim 38, characterized

25   in that the minimu neighborhood image area ones of the minimum image area to be coded have a number of pixels for each zone which is identical or different form the nmner of pixels forming the minimum image area to be coded.

30   40 A method according to one or more of the

preceding claims 9 to 34, characterized in that the digitalized image is coded according to the coding method of one or more of claims 35 to 39.